

An Overview of Landfill Gas Energy in the United States



U.S. Environmental Protection Agency
Landfill Methane Outreach Program (LMOP)

File Last Updated: June 2009



Why EPA is Concerned about Landfill Gas

- Why is methane a greenhouse gas?
 - Methane absorbs terrestrial infrared radiation (heat) that would otherwise escape to space (GHG characteristic)
- Methane as GHG is over 20x more potent by weight than CO₂
- Methane is more abundant in the atmosphere now than anytime in the past 400,000 years and 150% higher than in the year 1750
- Landfills were the second largest human-made source of methane in the United States in 2007, accounting for 22.7% generated



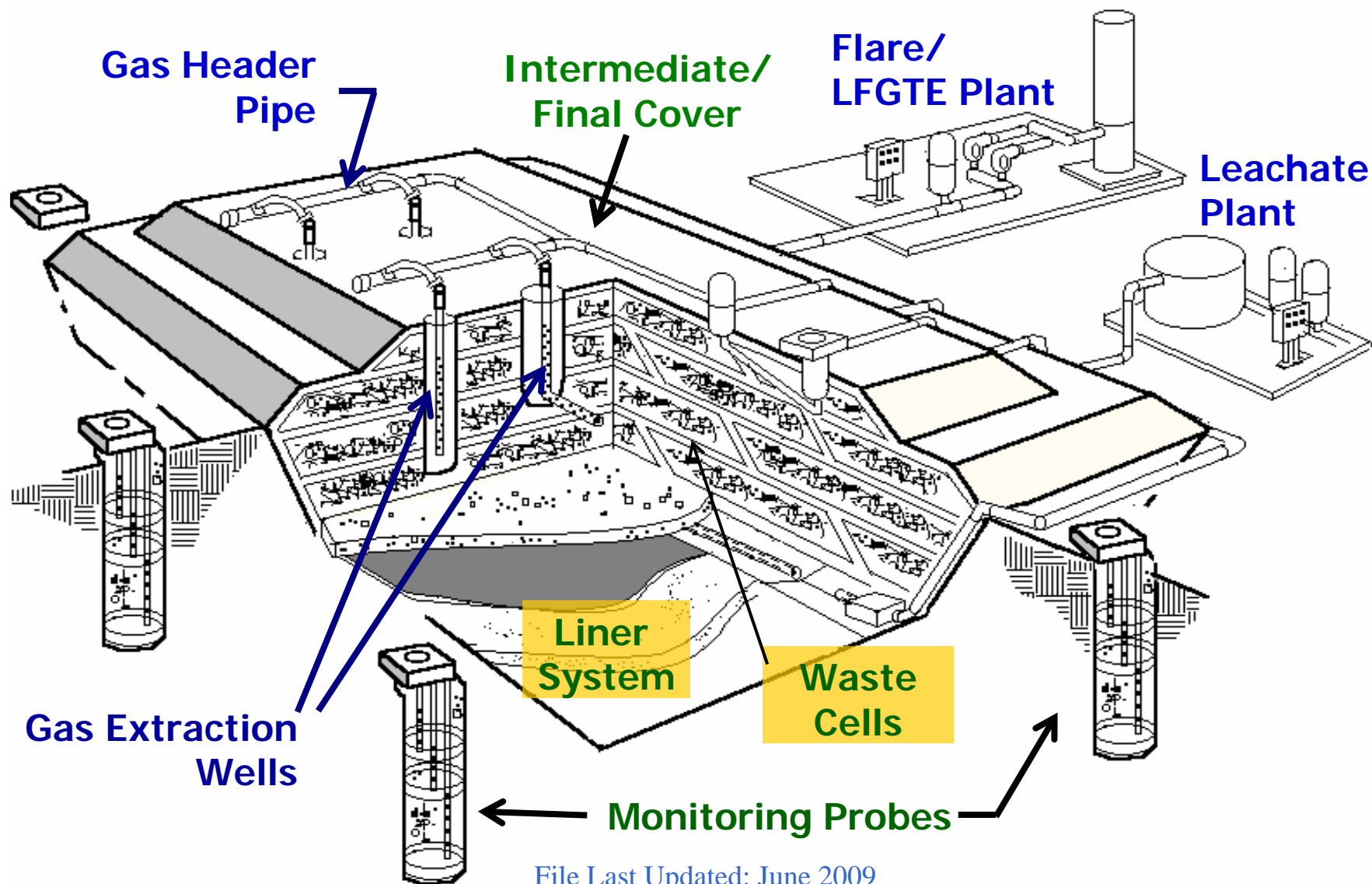


EPA's Landfill Methane Outreach Program

- Established in 1994
- Voluntary program that creates alliances among states, energy users/providers, the landfill gas industry, and communities

Mission: To reduce methane emissions by lowering barriers and promoting the development of cost-effective and environmentally beneficial landfill gas energy (LFGE) projects.

Modern Sanitary Landfill





Landfill Gas 101

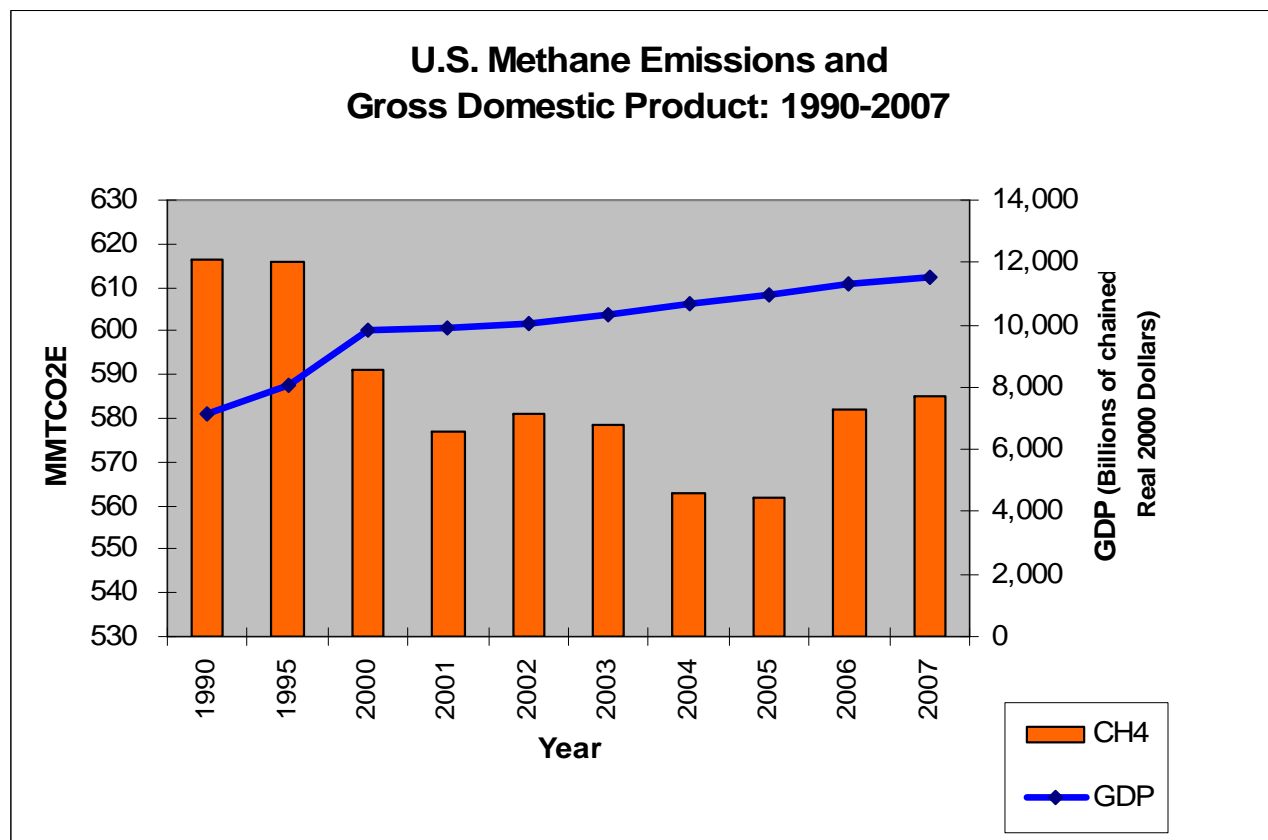
- Landfill gas (LFG) is a by-product of the decomposition of municipal solid waste (MSW):
 - ~50% methane (CH_4)
 - ~50% carbon dioxide (CO_2)
 - <1% non-methane organic compounds (NMOCs)
- For every 1 million tons of MSW:
 - ~0.8 megawatts (MW) of electricity
 - ~432,000 cubic feet per day of LFG
- If uncontrolled, LFG contributes to smog and global warming, and may cause health and safety concerns





Targeting Methane... Producing Measurable Results

Since 1990, U.S. methane emissions have decreased by 5% while GDP increased by 62%



Sources: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007, U.S. EPA, April 2009; DOC/Bureau of Economic Analysis. Interactive National Income and Product Accounts Table. Last revised on March 26, 2009.

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Landfill Gas and Green Power A Winning Combination

- Dual benefit → destroys methane and other organic compounds in LFG
- Offsets use of nonrenewable resources (coal, oil, gas) reducing emissions of SO_2 , NO_x , PM, CO_2
 - LFG is a recognized renewable energy resource (Green-e, EPA Green Power Partnership, 33 states, NRDC)
 - LFG is generated 24/7 and projects have online reliability over 90%
 - LFG can act as a long-term price and volatility hedge against fossil fuels



State of the National LFG Industry (April 2009)

- At least 485 operational projects in 44 states supplying:
 - 12 billion kilowatt-hours of electricity and 85 billion cubic feet of LFG to direct-use applications annually
- Estimated '09 **Annual Environmental Benefits**
 - Carbon sequestered annually by **~19,500,000 acres of pine or fir forests**, or
 - CO₂ emissions from **~199,000,000 barrels of oil consumed**, or
 - Annual greenhouse gas emissions from **~15,700,000 passenger vehicles**
- Estimated **Annual Energy Benefit**
 - Powering more than **889,000 homes** and heating nearly **614,000 homes**





Diversity of Project Types ***Electricity Generation***



**Internal
Combustion Engine**
(range from 100 kW to 3 MW)



Gas Turbine
(range from 800 kW to 10.5 MW)



Microturbine
(range from 30 kW to 250 kW)



Diversity of Project Types

Direct Use of LFG

- Direct-use projects are growing!

- Boiler applications – replace natural gas, coal, fuel oil
- Combined heat & power (CHP)
- Direct thermal (dryers, kilns)
- Natural gas pipeline injection
 - ◆ Medium & high Btu
- Greenhouse
- Leachate evaporation
- Vehicle fuel (LNG, CNG)
- Artist studio
- Hydroponics
- Aquaculture (fish farming)

Greenhouse Burlington, NJ



Pottery Studio Sugar Grove, NC



LFG-fired Boiler Ft. Wayne, IN



Emerging Technologies: LFG for Vehicle Fuel

- Los Angeles, CA converts LFG into CNG to fuel landfill equipment (Puente Hills LF)
- Orange Co, CA – 1st commercial LFG-to-LNG facility online Jan. '07 – used in county waste trucks (Frank R. Bowerman LF)
- Franklin Co, OH is creating CNG from LFG for use in county fleet
- POET plant in Sioux Falls, SD uses LFG from local landfill to create ethanol
- Central LF, CA plans to convert LFG to CNG to fuel Sonoma County school buses
- Waste Management in CA plans to produce 13,000 gal LNG per day for garbage trucks (Altamont LF)





Regulations that Affect LFGE

- LFGE projects may be affected by a variety of federal, state, and local air quality regulations. Applicable federal Clean Air Act regulations include:
 - New Source Performance Standards (NSPS) / Emission Guidelines (EG)
 - Title V
 - Maximum Achievable Control Technology (MACT)
 - New Source Review (NSR)
 - Prevention of Significant Deterioration (PSD)



LFG and RECs

- Renewable Energy Certificates (RECs)
 - Equivalent to 1 MWh of renewable energy generation
 - From \$5 to \$50 per MWh (0.5 to 5 cents per kWh)
- Companies looking to reduce their environmental footprint purchase RECs from utilities using LFG (2002-03)
 - Alcoa – 100% of electricity at 4 corporate locations from LFG
 - Delphi Corporation – 100% of electricity at largest corporate office from LFG
 - DuPont – 170 million kWh/yr from biomass & LFG
 - Pitney Bowes – 10% of electricity from wind & LFG
 - Staples – 46 million kWh/yr of RECs, 90% from biomass & LFG



American Recovery and Reinvestment Act of 2009

- \$71 billion for Clean Energy - \$50 billion increase over FY 2008 spending
- State and Local Governments
 - \$3.2 billion for Energy Efficiency and Conservation Block Grant Programs
 - \$3.1 billion distributed under the State Energy Program
 - Talk to your State energy office





American Recovery and Reinvestment Act of 2009 (cont.)

- Clean Renewable Energy Bonds (CREBs)
 - In lieu of interest, bond holders receive federal tax credits
 - \$2.4 billion made available for FY 2009
 - In 2008, IRS granted issuance authorization to 45 entities for LFGE projects
- Section 45 Production Tax Credit (PTC)
 - Electricity generation – 1.0 cent/kWh
 - Placed in service by 12/31/13
 - 10-year window for credits
 - Short-term option to select a one time 30% investment tax credit (Section 48) or convert into a 30% cash grant



Other Financial Incentives

- Federal Renewable Energy Production Incentive (REPI)
 - Local/state government or non-profit electric co-op facilities
 - Online by 10/1/16
 - Payment for first 10 years of operation
- Many State grants, tax exemptions, and other funding mechanisms
 - www.epa.gov/lmop/res/guide updated quarterly



Direct-Use Case Study **Lanchester Landfill Narvon, PA**

- ✓ First LFGE project in PA to serve multiple customers – will eventually provide LFG to 4 direct end users
- ✓ Not regulated by PUC as a public utility!
- ✓ 13-mile pipeline through 75 easements and 35 road crossings



**2005 LMOP
Award Winner**



Direct-Use Case Study **Lanchester Landfill** **Narvon, PA (cont.)**

- ✓ **Public and Private Partnerships**

- ✓ Granger Energy, Chester County Solid Waste Authority & PA DEP overcame economic & technical difficulties



- ✓ Three end users already using LFG in boilers, thermal oxidizers & ovens
- ✓ LFG fuels transport of itself – self-reliant project
- ✓ Estimated annual savings of \$300,000 in avoided electricity costs





CHP Case Study ***H₂Gro Greenhouses*** ***Lewiston, NY***

- Innovative Energy Systems' Model City Energy Facility at the Modern Landfill went online in June 2001
- 11 engine-generator sets produce a total of 12 MW of electricity
- Provides all electrical & heating requirements of H₂Gro's Greenhouses
- Excess electricity sold to grid
- H₂Gro initially constructed a ½ acre hydroponic greenhouse test cell and yielded 180,000 lb/yr of tomatoes
- Test so successful, expanded to 7½ acres and produces 3.5 million lb tomatoes/yr





CHP and Direct-Use Case Study **BMW Manufacturing Greer, SC**

LMOP 2003
*Project of
the Year*

- 9.5-mile pipeline from Palmetto Landfill to BMW
- 2003 – 4 KG2 gas turbines retrofitted to burn LFG
 - 4.8 MW of electricity generated and 72 million Btu/hr of heat recovered
- 2006 – Converted paint shop to utilize LFG in oven burners & for indirect heating
- LFG accounts for nearly 70% of BMW's energy needs
- To date, LFG has saved BMW an annual average of \$5 million in energy costs
- 2009/2010 – 2 new gas turbines will replace 4 older ones & generate 11 MW



LMOP 2006
*Energy End User
Partner of
the Year*



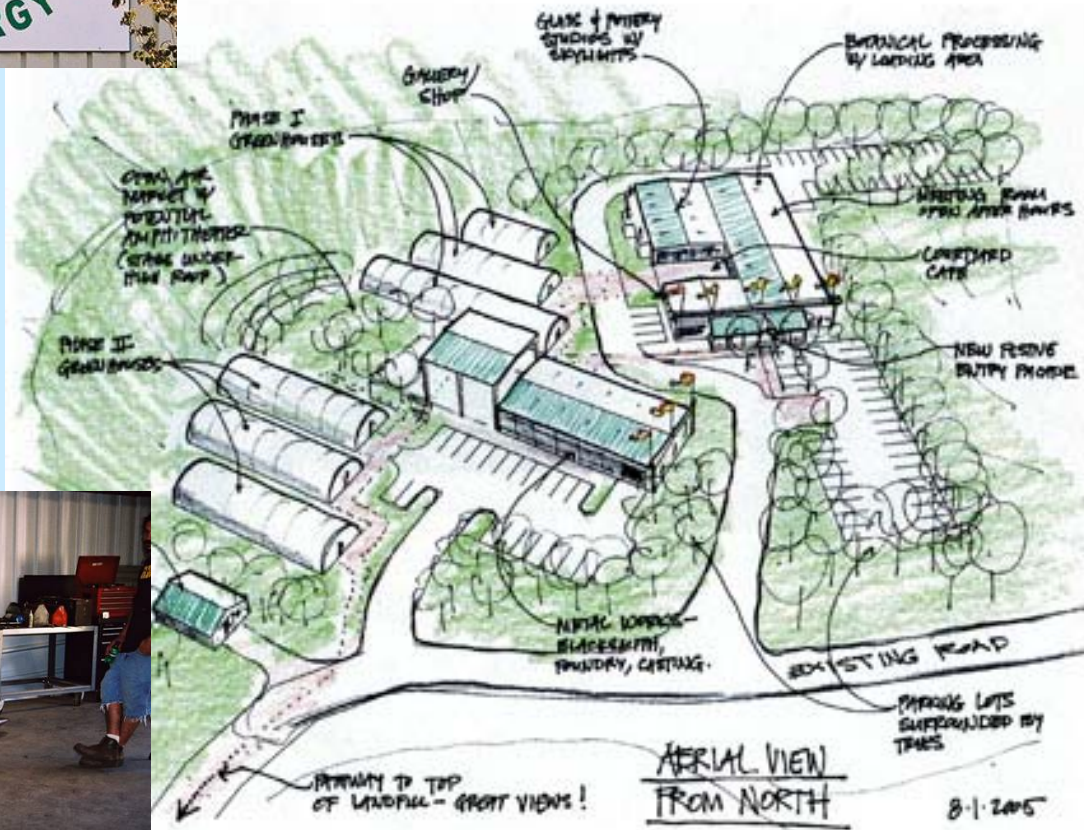
Direct-Use Case Study

Jackson County Green Energy Park

Sylva, NC



LMOP
2006
*Project of
the Year*





Electricity Case Study

Alameda Power & Telecom and City of Palo Alto, CA

- Two community-based utilities teamed up to meet renewable energy goals
- Alameda – currently 80% renewables
- Palo Alto goals – 10% of electric load from new renewables by 2008; 20% by 2015



LMOP
2007
*Energy
Partners
of the
Year*



- Buena Vista (3.2 MW) online in '06
 - Ox Mountain (11.4 MW) and Keller Canyon (3.8 MW) to be online in '09
- = Total of 18.4 MW
by end of 2009**



High Btu Case Study **Veolia ES Greentree LF Kersey, PA**

- Largest designed high Btu LFGE project in U.S. – can process 15.12 mmscfd LFG
- Cleaning: membrane technology, pressure swing absorption, carbon pretreatment, & H₂S removal
- 7-mile pipeline to combined cycle equipment



- Volume of LFG flared reduced by >90%
- Expect ~2 billion cf/yr product quality gas (<1% CO₂)
- Electricity
- RECs

*LMOP 2007
Project of
the Year*

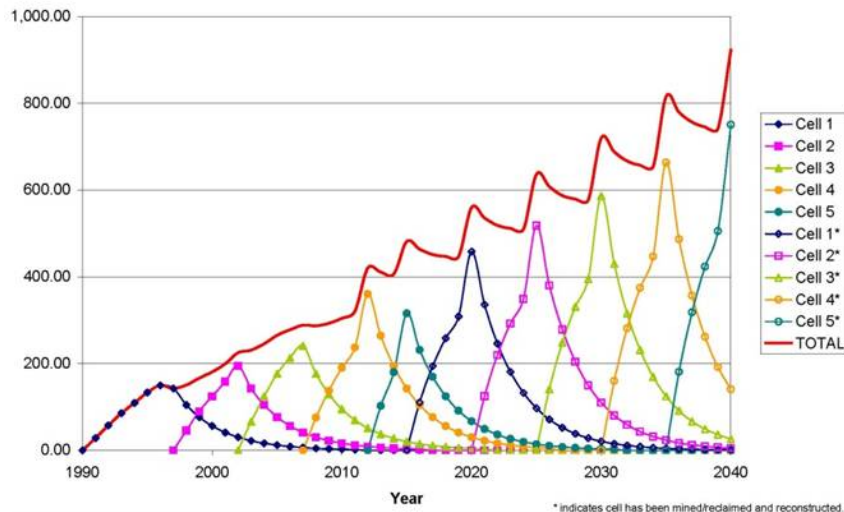


Central Landfill, Worcester County, MD

- Recirculating leachate – using leachate recharge wells for gas extraction (dual-use wellheads)
- Only **three** new dedicated gas wells needed – capital savings



Projected Methane Emission Rates
1990-2040



- Cell mining & reconstruction (extraction of humic material for soil amendment use)
- Will cycle through the cells – virtual indefinite use of space & slowly increasing gas supply



Central Landfill, Worcester County, MD (cont.)



- Selling: electricity (to Old Dominion Electric Coop), carbon credits (thru TerraPass) & RECs (to Pepco Holdings)
- Carbon credits verified by Voluntary Carbon Standard
- Estimated total value of renewable energy: \$100/MWh

- Provided business opportunities for local consultants, engineers, and construction contractors
- County will receive royalty payments for LFG
- Two 1-MW engines installed with third engine planned





Enoree Landfill, Greer, SC

- Selling: electricity (to Duke Energy), RECs (to Duke Energy), and carbon credits (through Sterling Planet)
- Carbon credits played a defining role in project - verified by Voluntary Carbon Standard
- Using Section 45 tax credits
- County benefit: \$300K/yr



- Generated & sold 90,000 tonnes of Verified Emission Reductions in first 5 months
- Expect to generate 120,000+ tonnes in 2009



File Last Updated: June 2009



Enoree Landfill, Greer, SC ***(cont.)***



- (2) Caterpillar G3520 engines generate 3.2 MW - 95% + online time at full capacity
- Built power line to the utility, could not sell to local coop

*LMOP 2008
Project of
the Year*

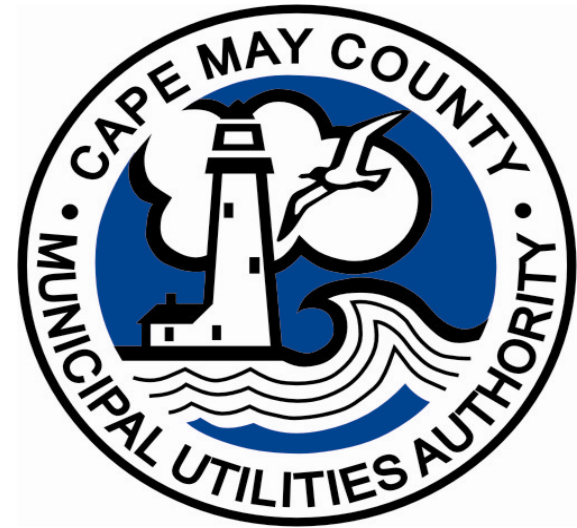
- Connected to 25 leachate cleanouts in addition to drilling 51 gas wells
- Advanced gas treatment system for siloxanes, water, and many non-methane hydrocarbons





Cape May County SLF, Woodbine, NJ

- Capital costs: \$858K minus \$285K grant = \$573K
- GCCS already in place from existing boiler project
- Simple payback of 2.5 years



- First year: \$71,500 from carbon credits and \$30,200 from RECs
- Selling credits on Chicago Climate Exchange:
\$3.00/metric ton in Feb. '08 and \$6.60/metric ton in May. '08



Cape May County SLF, Woodbine, NJ (cont.)



- (2) Waukesha 150-kW rich burn engines in 2007; (1) more added in 2008 (no grant for 3rd engine)
- Recover waste heat to heat maintenance facility & offices

- Only about 141 cfm total flows to the three engines
- Some electricity is used on-site, remainder sold to PJM
- Portion of site has leachate recirculation





Many Untapped LFG Resources

- Currently ~520 candidate landfills with a total gas generation potential of 200 billion cubic feet per year (~12,000 MMBtu/hr) OR electric potential of 1,180 MW (~9.5 million MWh/yr)
- If projects were developed at all these landfills, estimated
 - **Annual Environmental Benefit =**
Carbon sequestered annually by ~11.5 million acres of pine or fir forests OR annual greenhouse gas emissions from ~9.2 million passenger vehicles, AND
 - **Annual Energy Benefit =**
Powering 698,000 homes OR heating 1.4 million homes per year



LMOP Tools and Services

- Network of 800+ Partners (and growing)
- Newsletter and listserv
- Direct project assistance
- Technical and outreach publications
- Project and candidate landfill database
- Web site (epa.gov/lmop)
- Support for ribbon cuttings/ other PR
- Presentations at conferences
- State training workshops
- ***Annual LMOP Conference, Project Expo & Partner Awards***



EPA Administrator
Stephen L. Johnson

Keynote Speaker
11th Annual LMOP Conference
Washington, DC
January 9, 2008



How Can We Work Together? Direct Project Assistance

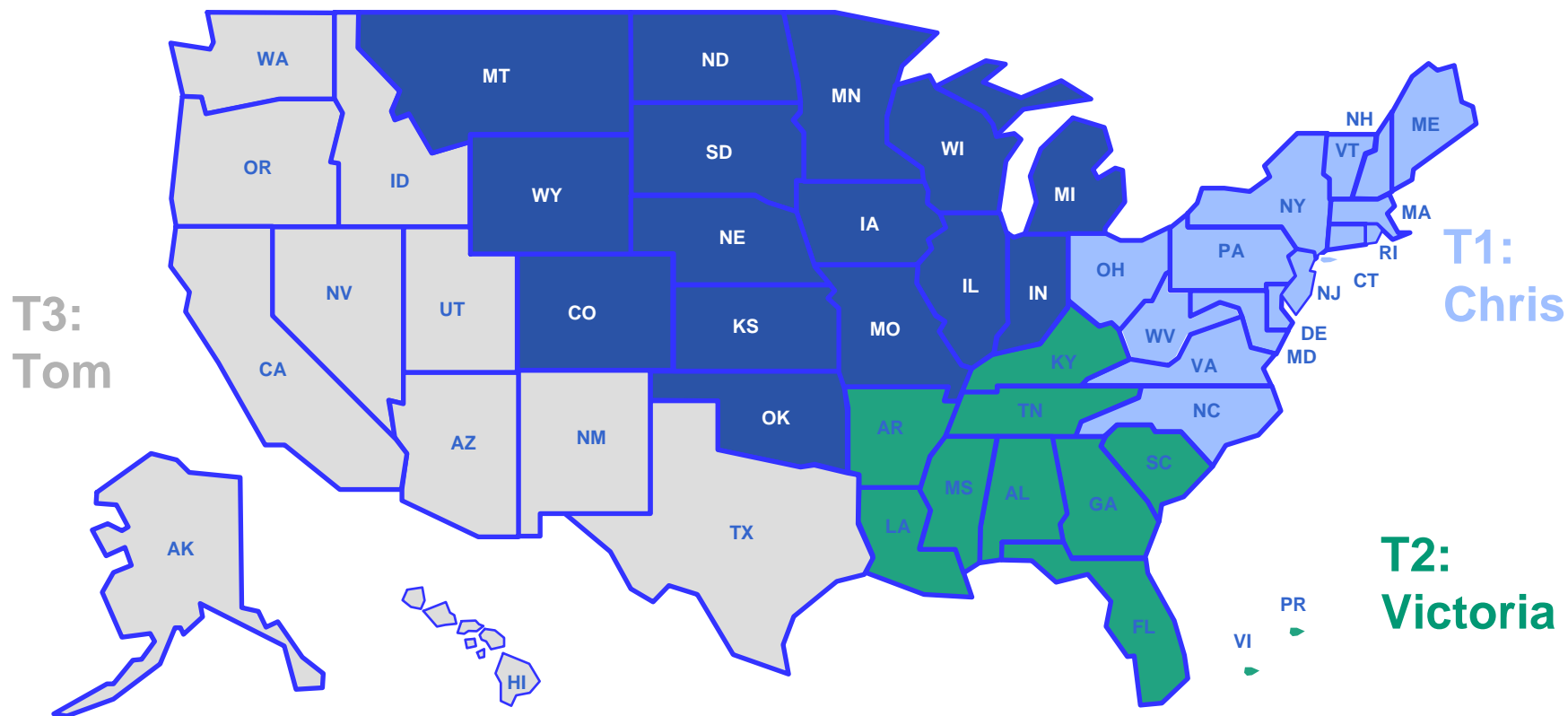
- Analyze landfill resource – gas modeling
- Identify potential matches – *LMOP Locator*
- Assess landfill and end user facilities
- Look at project possibilities
 - Direct-use (boiler, heating, cooling, direct thermal)
 - Combined Heat & Power (engine, turbine, microturbine)
 - Electric (engine, turbine, microturbine)
 - Alternative Fuels (medium or high Btu, LNG, CNG)
- Initial feasibility analyses – *LFGcost*



For More Information

www.epa.gov/lmop

T4: Swarupa



T1:
Chris

T2:
Victoria

Rachel Goldstein, Team Lead

goldstein.rachel@epa.gov, (202) 343-9391

Victoria Ludwig

ludwig.victoria@epa.gov, (202) 343-9291

Swarupa Ganguli

ganguli.swarupa@epa.gov, (202) 343-9732

Tom Frankiewicz

frankiewicz.thomas@epa.gov, (202) 343-9232

Chris Godlove

godlove.chris@epa.gov,
(202) 343-9795